

Approval of Preliminary Baseline Ranges (CD-1)
and Performance Baseline (CD-2)
for the
Run IIb CDF Detector Project
and the
Run IIb D-Zero Detector Project
at
Fermi National Accelerator Laboratory

Office of High Energy and Nuclear Physics
Office of Science

A. Purpose

This document is submitted to the Office of Science Energy Systems Acquisition Advisory Board (ESAAB)-equivalent for recommendation of Critical Decision One "Approval of Preliminary Baseline Range" and Critical Decision Two "Approval of Performance Baseline" (CD-2) of the Run IIb CDF Detector Project and Run IIb D-Zero Detector Projects at the Fermi National Accelerator Laboratory.

There are two separate projects under consideration. One will upgrade the CDF detector for Run IIb of the Tevatron and one will upgrade the D-Zero detector similarly. The two projects have very similar physics goals and technical scopes. Both are upgrades of the existing detectors and are being handled by personnel experienced in the construction of the existing detectors. Much of the planning and design has been done in parallel. Both projects have been reviewed together by the lab and the DOE.

The request for CD-1 and CD-2 Approval is due to the advanced state of the planning for the projects.

The Acquisition Executive (AE), upon signature of this document, will grant approval of CD-1 and CD-2. A description of the project and status of the prerequisites necessary for CD-1 and CD-2 approval are detailed in this document.

The AE, Dr. S. Peter Rosen, Associate Director of the Office of High Energy and Nuclear Physics (HENP), approved CD-0 for both projects on May 11, 2001. The preliminary project cost was \$15 million for each project at that time, and included only the replacement of the silicon vertex detectors. The baseline scope is slightly larger than that planned at CD-0.

B. Introduction to the CDF and D-Zero Run IIb Detector Projects

The CDF and D-Zero detectors are large, highly integrated systems of charged and neutral particle detectors designed to observe the proton-antiproton collisions at the

Fermilab Tevatron Collider, which is the highest energy particle accelerator in the world. The detectors were designed, assembled, and are now operated by two collaborations of physicists from U.S. universities, DOE national laboratories, and foreign institutions. Both detectors were significantly upgraded for Run II of the Tevatron which began in 2001.

Portions of the detectors will be damaged by radiation from the colliding beams over the next several years. Small sections of the electronics will not be able to function at the higher data rates planned for the later part of Run II of the Tevatron. The replacement of these portions is required to continue optimal operation until the end of the Tevatron program which will occur when the LHC begins publishing physics results.

The DOE portion of this work will be carried out under the DOE Management and Operating (M&O) contract with the Universities Research Association for the FNAL laboratory, which serves as the host laboratory and provides management infrastructure for the projects.

C. Mission Need and Justification

The Fermilab Tevatron provides the highest energy particle beams in the world, enabling unique opportunities for scientific discovery. Fermilab will continue to operate at the "Energy Frontier" until the Large Hadron Collider (LHC) at the European Organization for Nuclear Research (CERN) begins operation with a much higher beam energy at the earliest in late FY 2007. Thus, the Fermilab Tevatron Collider has a window of opportunity for making a major scientific discovery before handing off the baton to CERN.

Run II of the Tevatron will be the first comprehensive search for new physics of the TeV energy scale. New physics associated with electroweak symmetry breaking and the Higgs boson is expected. It may appear through the discovery of supersymmetric particles, new dynamics, signals for extra dimensions of space, or the observation of the Higgs boson.

Estimates indicate that, due to radiation damage, the current silicon detectors will only be useful up to 4 inverse femtobarns, which is expected to occur by 2006. The detector components provided by the Run IIb upgrades will allow the detectors to operate at high luminosity and meet the laboratory's goal of acquiring an integrated luminosity of 15 inverse femtobarns. This is a significant increase above the Run IIa goal of 2 inverse femtobarns and will enable a sensitive search for the Higgs Boson, which has been identified as a top priority by the HEPAP in its recent sub-panel report.

In June 2002, the Fermilab Program Advisory Committee reviewed the physics case for upgrading the two detectors and endorsed it. Subsequent to the review, the Fermilab Director granted stage I approval. The report stated:

"Maintaining the capabilities of the CDF and D0 detectors throughout the run is also essential for the success of Run II. The development of the upgrade plans that will

ensure adequate performance, while meeting the rigorous schedule and fiscal constraints that the Laboratory faces, has been a challenge. While the Committee believes this challenge has been met, it also recognizes the necessity to proceed to a full baseline review of the projects by late summer. On this basis, the Committee recommends Stage I approval for the CDF and D0 Run IIb upgrade projects."

D. Design Report

A Conceptual Design Report is required for CD-1, and a Preliminary Design Report is required for CD-2. Technical design documents for each project exist, and satisfy these requirements. The *D-Zero Run IIb Technical Design Report* by the D-Zero Collaboration (Fermilab-Pub-02/327-E) was released September 12, 2002. The *CDF IIb Detector: Technical Design Report* by the CDF Collaboration was also released September 12, 2002.

E. Project Execution Plan

The preliminary Project Execution Plan is a prerequisite for CD-1 and the final Project Execution Plan (PEP) is a prerequisite for the CD-2 approval. The final PEP has been completed and available for AE approval at the time of CD-2 approval. It describes the scope and management of the DOE responsibilities and establishes the performance baseline for both projects.

F. Project Scope Baseline

The baseline scopes of the Run IIb CDF and D-Zero Detector Projects are the fabrication of detector components to be installed in the CDF and D-Zero detectors.

Run IIb CDF Project

- Replacement of inner silicon vertex detector with a new, more radiation resistant version capable of maintaining the current performance through the entire Run IIb of the Tevatron.
- Upgrade of the central calorimetry, to provide improved time measurement of electromagnetic energy deposition and a replacement for the obsolete central preradiator chambers.
- Replacement of obsolete portions of the data acquisition system that prevent the experiment from collecting data at the rates needed in Run IIb.

Run IIb D-Zero Project

- Replacement of silicon vertex detector with a new, more radiation resistant version capable of maintaining the current performance through the entire Run IIb of the Tevatron.

- Upgrade of the Level 1 and Level 2 trigger systems to accommodate the higher luminosities from the Tevatron.
- Replacement of obsolete portions of the online and data acquisition systems that would otherwise prevent the experiment from taking data at rates necessary to achieve the physics objectives of Run IIb.

The project will be completed when all components are fabricated and tested to the extent possible outside of the CDF and D-Zero detectors. Details of the required testing are in the PEP. The projects end with Approval of Critical Decision Four (CD-4), scheduled for November 2006.

G. Project Funding

The project funding is dominated by the DOE Major Item of Equipment (MIE) funds, but there are also contributions from U.S. universities and foreign sources for both projects and NSF Major Research Infrastructure (MRI) grants in the case of D-Zero. The DOE MIE is \$25.0 million for CDF and \$20.6 million for D-Zero. The Total Cost is \$30.4 million for CDF and \$28.6 million for D-Zero.

The breakdown of the funding by year and source is given below.

Planned Funding (AY in millions)							
	FY01	FY02	FY03	FY04	FY05	FY06	Total
Run IIb CDF Detector Project							
DOE MIE	0	3.5	3.5	8.4	8.5	1.1	25.0
DOE R&D	0	1.7	0.5	0	0	0	2.1
Foreign Funding	0	0.3	1.2	1.3	0	0	2.9
U.S. Universities ¹	0	0	0.2	0.1	0	0	0.4
Total	0	5.5	5.4	9.8	8.5	1.1	30.4
Run IIb D-Zero Detector Project							
DOE MIE	0	3.5	2.8	8.6	5.8	0	20.6
DOE R&D	0	1.5	2.4	0	0	0	3.9
Foreign Funding	0	0.3	0.2	0.1	0	0	0.6
NSF-MRI	0	1.3	0.6	0.7	0.4	0	3.1
U.S. Universities ¹	0	0.2	0.1	0	0	0	0.4
Total	0	6.8	6.1	9.4	6.3	0	28.6

¹The U.S. Universities' contributions are not funded by the DOE. They consist of matching contributions to the NSF MRI grants, junior faculty start up funds, and other types of university contributions.

H. Project Cost and Schedule Baselines

The schedule is described by the projects' Critical Decision milestones, which are given below. Both projects have the same CD milestones. The CD-3a approval for limited

construction is needed to begin the project acquisitions. Delay of these acquisitions will delay the completion of the project.

CD Milestones

Milestone	Description	Baseline Date
0.0	CD-0: Approve Mission Need	May 2001 (actual)
0.1	CD-1: Approve Preliminary Baseline	December 2002
0.2	CD-2: Approve Performance Baseline	December 2002
0.3	CD-3a: Approve Limited Construction	December 2002
0.4	CD-3b: Approve Full Construction	September 2003
0.5	CD-4: Approve Project Completion	November 2006

The cost baseline of the projects broken down by WBS items and is shown below.

Costs (AY in millions)			
WBS	Item	Total Cost*	DOE MIE
CDF Run IIb Detector Project			
1.1	Silicon Detector	15.2	11.5
1.2	Calorimeter Upgrades	1.1	0.3
1.3	Data Acquisition Upgrades	4.7	4.0
1.4	Administration	1.6	1.3
	Contingency	7.9	7.9
	TOTAL	\$30.4	25.0
D-Zero Run IIb Detector Project			
1.1	Silicon Detector	16.0	10.0
1.2	Trigger Upgrades	3.3	1.6
1.3	Online Computing	1.1	1.1
1.4	Administration	1.5	1.5
	Contingency	6.8	6.5
	TOTAL	\$28.6	\$20.6

*Includes contributions from other funding sources

I. Acquisition Execution Plan

An Acquisition Execution Plan (AEP) is required for CD-1 approval. The document has been finalized, reviewed by OECM as required, and is currently in the signature process.

The acquisition strategy outlined in the AEP recognizes that the nature of the projects involve significant scientific and technical expertise with the existing detectors at Fermilab as well as expert knowledge of high energy physics. This expertise is only

found within the laboratory workforce and the CDF and D-Zero collaborations who are currently performing the research, development, engineering and experimentation on the detectors and no other entity has the ability to execute the upgrades. The modifications will be to in-place and operating systems that require intimate knowledge of and interaction with other laboratory organizational elements, which no other entity has the ability to accomplish.

Relying on Fermilab's M&O contractor, URA, to function as prime contractor for the projects best facilitates the collaborations' involvement, since the only natural point of contact for this diverse group is at the Laboratory. Laboratory construction projects are within the scope of the URA/DOE contract, and URA has successfully managed this type of technical procurements in the past in its management and operations role at Fermilab. The final selection of this acquisition strategy was also based on other significant factors, in particular, the availability of existing laboratory project, technical, administrative, and support staff to support the projects' needs.

The management of the Run IIb upgrade projects is the responsibility of Fermilab and is carried out by the CDF project manager and collaboration management team and the D-Zero project manager and collaboration management team.

J. Baseline and Preliminary Design Review

A baseline readiness review was held at Fermilab on September 24-26, 2002, organized by the Construction Management Support Division covering the status of the technical design, cost, schedule, and management structure. The review committee recommended that the projects are ready to be baselined, providing that the schedule and cost contingency be revised as recommended.

K. External Independent Review and Independent Cost Review

An External Independent Review (EIR)/Independent Cost Review (ICR) of the projects was conducted by the JUPITER Corporation for the OECM. The final report from this review was issued on December 2, 2002. The review team concluded that "both projects are quality projects, each with a scope appropriately defined by the scientific experiment that the successful execution of these projects will enable. The projects are being well managed. Each has effectively employed peer review—characteristic of scientific research within academia—to provide the rigor to the project management process necessary to project success. Merging the best elements of modern project management as reflected in DOE O 413.3 and DOE project management guidance with the peer review process, without compromising either, is a noteworthy accomplishment of these two projects. The design documents developed to this point seem appropriate and are very comprehensive. The use of physical models and mockups by the projects in the development of design is also noteworthy. Further, the EIR/ICR Team noted other positive practices being followed, including the broad and systematic application of Value Engineering. The cost estimate, as checked by the ICR, is reasonable and realistic." Two essential findings and one finding resulted from the review. A corrective

action plan has been developed and all essential findings and findings will be addressed prior to the ESAAB.

L. Project Management Control Systems Review

A Project Management Control Systems Review was conducted on November 13 and 14 at the direction of the DOE Run II Project Manager. The final report was issued on November 25, 2002. The review committee offered recommendations to the projects and concluded that it was "confident that the necessary reports and information will be ready when needed by the projects." Response to the recommendations will be submitted prior to the ESAAB.

M. Environmental Strategy

The Categorical Exclusions (B3.10) for the Run IIb CDF Detector project and the Run IIb D-Zero Detector projects were approved on September 17 and 30, 2002, respectively.

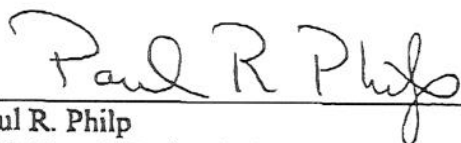
N. Safety Analysis Document

The original CDF and D-Zero Detectors were designated as Low Hazard Radiological Facilities and the Safety Envelopes were approved by DOE in November 1994 and November 1995, following submission of the Safety Assessment Documents (SADs). Addendums to the SADs were submitted and approved for the Run IIa Upgrades, and the radiological facility designations remained unchanged. In compliance with the Fermilab ES&H Manual, the Directorate, through the ES&H Section, has determined that a Run IIb addenda to the existing CDF and D-Zero SADs should be prepared prior to Run IIb operations. No aspect of the Run IIb CDF and D-Zero Detector Projects will increase the hazards of the experiments for either radiological or conventional hazards. Consequently, a complete reanalysis of the Safety Assessment Documents is not warranted.

December 17, 2002

Run IIb CDF and D-Zero Detector Projects

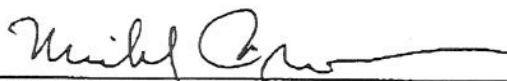
CD-1 & CD-2

Run IIb CDF and D-Zero Detector Projects CD-1 & CD-2 Review**Submitted by:**

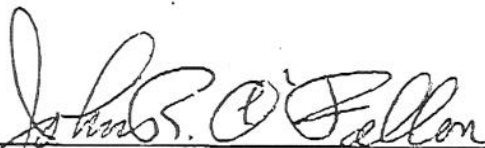
Paul R. Philp
DOE Run II Project Manager
Fermi Area Office

Date: 12-12-02

Jane L. Monhart
Fermi Area Office Manager

Date: 12-13-02

Michael P. Procario
Program Manager for Run IIb Detector Projects
Division of High Energy Physics

Date: 12-13-02

John R. O'Fallon
Director, Division of High Energy Physics

Date: 12/16/02

December 17, 2002

Run IIb CDF and D-Zero Detector Projects

CD-1 & CD-2

Run IIb CDF and D-Zero Detector Projects CD-1 & CD-2 Review

Recommendations

The undersigned "Do Recommend" (Yes) or "Do Not Recommend" (No) Approval of CD-1, Approval of Preliminary Baseline Range, and CD-2, Approval of Performance Baseline, for the Run IIb CDF and D-Zero Detector Projects at FNAL as noted below.

[Signature] 12/17/02 Yes ☒ No ☐
ESAAB Secretariat, Construction Management and Support Division/ Date

[Signature] 17 DEC 02 Yes ☒ No ☐
Representative, Non-Proponent SC Program Office/ Date

[Signature] 12-17-02 Yes ☒ No ☐
Representative, Environmental Safety and Health Division/ Date

[Signature] 12-17-02 Yes ☒ No ☐
Representative, Financial Management Division / Date

Representative, Security Management Team / Date Yes ☐ No ☐

Representative, Grants & Contracts Division / Date Yes ☐ No ☐

[Signature] 17 Dec 02 Yes ☒ No ☐
Representative, Laboratory Infrastructure Division/ Date

Approval

Based on the material presented above and this review, Critical Decision 1, Approval of Preliminary Baseline Range, and Critical Decision 2, Approval of Performance Baseline, for the Run IIb CDF and D-Zero Detector Projects are approved as Major Items of Equipment. Therefore, the Fermi Area Office is authorized to proceed with expenditure of Major Item of Equipment funds for the Run IIb CDF and D-Zero Detector Projects.

S. Peter Rosen
S. Peter Rosen
Associate Director
Office of High Energy and Nuclear Physics
Office of Science

FEB 6 2003

Date